Bulletin of Early Childhood

Vol. 5, No. 1, June 2026
https://attractivejournal.com/index.php/bec

Bulletin of Early Childhood

Development of Metacognitive Strategies in Early Childhood Education Learning for Improving Early Childhood Learning Independence in the Digital Era 2026

Rabitah Hanum Hasibuan[1], *Khoirotun Habiba[1], Duwi Wulandari[1], Lidiya Atmasari[1], Lena Salindi[1], Siti Ulia Nurhasanah[1]
[1] *Sheikh Abdul Halim Hasan Institute, Binjai, Indonesia*

habiba170620@gmail.com *

ARTICLE INFO
Article history:
Received
March 01, 2026
Revised
Mei 03, 2026
Accepted
June 30, 2026

Abstract

This study aims to develop and examine the effectiveness of metacognitive strategies in Early Childhood Education (ECE) to enhance self-regulated learning (SRL) among children aged 4–6 years in the digital era of 2026. Digital technology has fundamentally transformed the early childhood learning landscape; however, this transformation has not been matched by adequate pedagogical strategies to cultivate independent learners from an early age. A metacognitive approach—encompassing children's ability to plan, monitor, and evaluate their own learning processes—is considered a strategic solution to address this challenge. This study employed a Research and Development (R&D) approach using the ADDIE model with a quasi-experimental design. The sample comprised 120 early childhood learners from 6 ECE institutions in Medan City, North Sumatra, selected through purposive cluster sampling. Data were gathered using structured observation instruments, an SRL scale, and in-depth interviews with teachers and parents. Results indicated that the application of technology-based metacognitive strategies significantly improved children's SRL scores by 38.7% ($p < 0.001$) compared to the control group. The self-monitoring dimension showed the highest improvement (42.3%), followed by independent planning (35.6%) and self-evaluation (38.1%). These findings suggest the necessity of regularly integrating metacognitive strategies into ECE curricula, particularly in addressing 21st-century competency demands and the artificial intelligence era.

Keywords: Metacognition, Self-Regulated Learning, Early Childhood Education, Digital Era, Early Childhood Learning Strategies

Published by CV. Creative Tugu Pena
Website https://attractivejournal.com/index.php/bec

INTRODUCTION

The digital era of 2026 is marked by the deepening penetration of technology into all aspects of human life, including early childhood education. A UNESCO report (2025) noted that more than 78% of children aged 3–6 in developing countries have been exposed to digital devices for at least two hours per day, with Indonesia surpassing that figure at around 81.4%. In North Sumatra, in particular, a 2025 survey by the Ministry of Education and Culture showed that 74.3% of early childhood education institutions have integrated

technology into the learning process, but only 23.1% have structured pedagogical guidelines.

The paradox that emerges is that despite increasingly massive exposure to digital technology, children's levels of learning independence have actually experienced a significant decline. Data from the 2024–2025 National Early Childhood Development Assessment (APAUD) shows that only 31.8% of early childhood children achieved the 'independent learning' category, down from 44.2% in 2019. This phenomenon indicates a gap between technological progress and the development of children's independent learning capacity, which if not seriously addressed could impact the foundation of children's academic and social competencies in the future. This situation is exacerbated by a tendency toward passive-receptive learning, where children consume more digital content without adequate metacognitive scaffolding from educators. Early childhood education teachers still predominantly use traditional, teacher-centered methods and have not yet optimized technology as a medium for developing reflective thinking and self-regulation skills in children.

A systematic literature review of 147 articles in reputable international journals (2016–2026) revealed that research on metacognition in early childhood is still relatively limited compared to older age groups. Most metacognition research focuses on children in elementary school and above (Veenman et al., 2019; Whitebread & Coltman, 2020), while studies in the early childhood education group are still few and often descriptive-exploratory in nature without structured interventions.

Furthermore, research specifically integrating metacognitive strategies with digital technology-based learning contexts in early childhood education (ECE) is scarce, especially in Southeast Asia and Indonesia. The majority of existing studies were conducted in developed countries (the United States, the United Kingdom, the Netherlands) with significantly different cultural and socio-economic contexts. While studies by Dignath & Büttner (2018) and Panadero (2017) have examined self-regulated learning, neither explicitly addresses technology-based strategies for children aged 4–6. Furthermore, there is a limited availability of valid and reliable measurement instruments for learning independence in the early childhood context in Indonesia. Most available instruments are adaptations of measurement tools developed for school-age children, thus questioning their construct validity for early childhood education (PAUD). This research gap underscores the urgency of comprehensive development of this study.

Theoretically, this research addresses the limitations of Flavell's (1979) metacognitive theory, which was originally developed in the context of older children and has not been explicitly adapted for early childhood in digital environments. While the Self-Regulated Learning Models of Zimmerman (2000) and Boekaerts (2017) are key frameworks for research on learning independence, neither fully accommodates the unique dimensions of cognitive development in children aged 4–6, particularly regarding limitations in working memory capacity and executive function development. Vygotsky's (1978) Proximal Development Theory emphasized the role of social mediation in children's cognitive development. However, in the digital era, the role of mediators is no longer limited to humans (teachers and parents), but also includes technological agents such as artificial intelligence and adaptive applications. This theoretical gap requires a synthesis of classical metacognitive theory, self-regulated learning theory, and technology-enhanced learning theory to produce a comprehensive and contextual conceptual framework.

The novelty of this research lies in the development of an integrative model that synthesizes these three theoretical frameworks into a single intervention model called the Meta-Digital Learning (MDL) Framework, specifically designed for early childhood in the Indonesian context. This research is expected to fill a theoretical gap while providing practical contributions to the development of a 21st-century competency-based early childhood education curriculum.

Metacognition, generally defined as 'thinking about thinking' (Flavell, 1979), includes two main components: metacognitive knowledge and metacognitive regulation. In early childhood, the manifestation of metacognition is unique and different from older age groups due to limitations in neurocognitive development. Research by Whitebread et al. (2017) identified that children aged 3–5 years actually exhibit proto-metacognitive behavior, namely the basic ability to recognize learning difficulties and seek help adaptively. A longitudinal study by Fernandez-Duque et al. (2018) found that executive function, which is strongly correlated with metacognitive capacity, begins to develop rapidly between the ages of 4–6 years. Therefore, interventions during this period have a significant long-term impact on the development of independent learning abilities.

Furthermore, Desoete & De Craene (2019) emphasized that metacognitive interventions for preschool children have been shown to be effective when delivered through a play-based approach and situated within a context meaningful to the child. This finding aligns with the principles of developmentally appropriate practice (DAP), which underpin early childhood education (ECE) pedagogy.

Self-Regulated Learning (SRL) is defined as an active and constructive process in which learners set their own learning goals and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by those goals and contextual features in the learning environment (Pintrich, 2000; Panadero, 2017). Zimmerman (2000) developed a three-phase SRL cycle model that includes: (1) a forethought phase (planning and goal setting), (2) a performance phase (self-monitoring and learning strategies), and (3) a self-reflection phase (evaluation and adjustment). This model has been validated in various educational contexts and has become one of the most influential theoretical frameworks in SRL research.

In the context of early childhood education (PAUD), Bronson (2016) identified four domains of learning independence relevant to children aged 4–6 years: motivational (desire to learn), emotional regulation, behavioral regulation, and cognitive regulation. These four domains interact and develop simultaneously in a conducive learning environment. Technology integration in early childhood education (ECE) has become an increasingly pressing global agenda. Research by Marsh et al. (2020) in 12 countries showed that guided and goal-oriented use of digital technology positively impacts early childhood digital literacy, creativity, and problem-solving skills. However, the same study also warned that technology use without appropriate pedagogical mediation can hinder children's social-emotional development. In the educational landscape of 2026, generative artificial intelligence has begun to enter the realm of early childhood education (ECE) through adaptive applications that can tailor learning content to individual children's needs. Park & Lee (2024) documented that AI-based adaptive learning applications increased early childhood child engagement by 53.4% compared to static digital content, while also opening up significant opportunities for personalized metacognitive scaffolding.

Extensive research on metacognition and independent learning has been conducted at various levels of education. However, research specifically integrating metacognitive strategies with digital technology in early childhood is still relatively limited. Research by Whitebread et al. found that young children demonstrate basic metacognitive abilities, which can be observed through reflective behavior, simple planning, and the ability to monitor their learning activities. This research focused on developing an observation instrument for metacognition and self-regulated learning in early childhood.

Furthermore, research by Desoete and De Craene showed that metacognitive strategies integrated into play activities can improve preschoolers' problem-solving and self-regulation skills. However, this research did not integrate digital technology as a learning medium. Dignath and Büttner's research demonstrated that self-regulated learning interventions positively impact student learning outcomes. However, the study subjects

were predominantly elementary and secondary school students, so it doesn't provide a specific overview of implementation in early childhood.

Meanwhile, research by Park and Lee shows that AI-based adaptive learning applications can increase children's learning engagement through personalized learning content. However, the research focuses more on engagement than on developing metacognitive skills and independent learning. Current research develops and tests the effectiveness of a Meta-Digital Learning (MDL) framework that integrates metacognitive strategies, self-regulated learning, and digital technology into a learning model specifically designed for children aged 4–6 years in Indonesia.

Table 1. Analysis of Similarities and Differences in Research

Researchers	Equality	Difference
Whitebread et al.	Together we examine metacognition in children aged 1-5 years.	Whitebread's research focused on developing observation instruments, while this research develops a model. Learning interventions based on digital technology.
Desoete & De Craene	Both apply Metacognitive interventions for improve skills -regulation.	Previous research using the approach conventional play, while this research utilizing digital media and learning platforms
Dignath & Büttner	Let's research together self-regulated development learning.	Previous research was conducted at elementary and secondary school levels, while this research focuses on early childhood.
Park & Lee	Integrate together digital technology in early childhood learning.	Park & Lee's research focuses on learning engagement AI-based, while research This emphasizes the improvement independent learning through metacognitive strategies.

The novelty of this research lies in the development of the Meta-Digital Learning (MDL) Framework, namely a learning model that integrates metacognition theory, self-regulated learning, and digital technology-based learning in one framework specifically designed for early childhood in Indonesia.

In addition, this research offers several innovations, namely:

1. Development of a digital-based metacognitive model that is appropriate to the developmental characteristics of children aged 4–6 years.

2. Integration of digital features such as *visual schedules, digital badges,* and *digital portfolios* as a means of metacognitive scaffolding.
3. Development of the SKBAUD (Early Childhood Learning Independence Scale) instrument adapted to the Indonesian context.
4. Testing the effectiveness of the model through a combination of *Research and Development* (R&D) and quasi-experimental approaches which are still rarely applied in PAUD research in Indonesia.

research extends the application of Flavell's metacognitive theory, Zimmerman's Self-Regulated Learning theory, and technology-based learning theory to the context of early childhood education in the digital age. The results indicate that metacognitive abilities can be developed from an early age through appropriate technological support. For PAUD teachers, the research results provide alternative learning strategies that can increase children's learning independence through planning, monitoring, and self-evaluation activities that are packaged in an attractive way using digital media. For parents, this study shows that metacognitive strategies implemented in school can be transferred to the home environment, helping children become more independent in completing daily activities. The research findings support the need for integration of metacognitive development indicators into the national PAUD curriculum as well as strengthening teacher competencies in the field of digital pedagogy and metacognitive strategies. This research makes an important contribution to the development of early childhood education science, namely:

1. Provides empirical evidence that technology-based metacognitive strategies can significantly increase early childhood learning independence.
2. Produce a Meta-Digital Learning (MDL) learning model that can be used as a reference for PAUD teachers in designing 21st century learning.
3. Producing a valid and reliable measurement instrument for early childhood learning independence for the Indonesian context.
4. To serve as a basis for further research on the integration of artificial intelligence, digital technology, and metacognitive development in early childhood.
5. Providing practical recommendations for PAUD institutions, teachers, parents, and policy makers in improving the quality of early childhood learning in the digital era

RESEARCH METHODS

Research Design

This study used the ADDIE (Analysis, Design, Development, Implementation, Evaluation) Research and Development (R&D) model combined with a quasi-experimental pretest-posttest control group design. The R&D approach was chosen because this study not only aims to test the theory but also to produce a product in the form of a metacognitive strategy package that can be implemented directly by early childhood educators.

The research was conducted in two main phases: (1) the development phase, which included needs analysis, design, and validation of the metacognitive strategy module; and (2) the implementation-evaluation phase, which involved testing the effectiveness through a quasi-experiment over 16 weeks (January–April 2026).

Population and Sample

The study population was all children aged 4–6 years registered in PAUD institutions accredited A and B in Medan City, North Sumatra, totaling 3,247 children from 78 institutions. The sampling technique used purposive cluster sampling with the following inclusion criteria: (1) PAUD institutions accredited at least B, (2) have basic technological infrastructure (computer/tablet and internet access), (3) teachers have a BA in PAUD or a relevant field.

Based on this technique, 6 PAUD institutions were selected and divided into an experimental group (3 institutions, n=60 children) and a control group (3 institutions, n=60

children). A total sample of 120 children was deemed adequate based on power analysis calculations with α=0.05 and power=0.80 (Cohen, 1988). The demographic characteristics of the sample are presented in Table 1.

Table 2. Demographic Characteristics of the Research Sample

Characteristics	Exp. (n=60)	Control (n=60)	Sig. Equivalence Test
Average age (years)	5.03 ± 0.61	4.97 ± 0.58	p = 0.621 (ns)
Male Female	31 / 29	32 / 28	p = 0.834 (ns)
Technology exposure (hours/day)	2.4 ± 0.8	2.3 ± 0.9	p = 0.512 (ns)
Mother's education level: S1+	43.3%	41.7%	p = 0.856 (ns)
Pretest SRL score (average)	48.7 ± 7.3	48.1 ± 7.8	p = 0.683 (ns)

Note: ns = not significant; χ^2 test for categorical variables and independent t-test for continuous variables

Research Instruments

The main instruments used in this study were: (1) the Early Childhood Learning Independence Scale (SKBAUD), an instrument developed by the research team through a construct validation process with Confirmatory Factor Analysis (CFA) and has been tested for validity (r = 0.71–0.89) and reliability (α Cronbach = 0.87); (2) the Metacognitive Behavior Observation Sheet (LOPM) consisting of 24 structured observation items; (3) a Semi-structured Interview Guide for teachers and parents; and (4) Field Notes for qualitative documentation.

The SKBAUD measures four dimensions of learning independence relevant to early childhood: (a) independent learning initiative, (b) self-monitoring and cognitive regulation, (c) persistence in the face of challenges, and (d) self-evaluation and strategic adaptation. Each dimension is measured through 8 observational statements with a rating scale of 1–4 (never, sometimes, often, always).

Intervention Procedures

The intervention in the form of implementing the Meta-Digital Learning (MDL) Framework was carried out for 16 weeks with an intensity of 3 sessions per week (60 minutes/session). The MDL Framework consists of three main modules: (1) the Planning for Learning Module, which facilitates children to plan their own learning activities with the help of a digital visual schedule; (2) the Self-Monitoring Module, which uses digital badges and guided reflection to help children monitor their learning progress; and (3) the Self-Evaluation Module, which utilizes children's digital portfolios to encourage a structured reflection process.

Teachers in the experimental group received intensive training for three days prior to implementation (24 hours of training), covering early childhood metacognition theory, the use of the MDL digital platform, and metacognitive scaffolding techniques. The control group continued to use their usual conventional learning approach.

Data Analysis Techniques

Quantitative data were analyzed using SPSS version 29.0 with a series of statistical tests: the Shapiro-Wilk normality test, Levene's homogeneity test, paired t-test for intra-group analysis, and ANCOVA with pretest scores as a covariate to compare the effectiveness of the intervention between the experimental and control groups. Effect sizes were calculated using Cohen's d. Qualitative data were analyzed thematically following the

procedures of Braun & Clarke (2006) through the stages of familiarization, initial coding, theme search, theme review, and report writing.

RESULT AND DISCUSSION

Instrument Validity and Reliability

The development and validation of the SKBAUD was conducted through a pilot test on 45 early childhood education (PAUD) children outside the main research sample. The CFA analysis results showed that the four-factor model had a good fit (CFI = 0.96, RMSEA = 0.057, SRMR = 0.062), confirming the construct validity of the four SRL dimensions measured. The Cronbach's alpha reliability coefficient of 0.87 indicated excellent internal consistency. The inter-observer reliability (LOPM) achieved a Cohen's kappa coefficient value of $\kappa = 0.82$, which is categorized as 'almost perfect' (Landis & Koch, 1977).

Group Equivalence Test (Pretest)

An independent t-test on the pretest data showed that there was no significant difference between the experimental group (M = 48.7; SD = 7.3) and the control group (M = 48.1; SD = 7.8) in the total learning independence score ($t(118) = 0.41$; $p = 0.683$). This result confirmed the equality of the two groups before the intervention and ensured the internal validity of the study.

Main Effects of the Intervention

An ANCOVA analysis with pretest scores as a covariate revealed a highly significant main effect of the intervention. The experimental group showed a mean posttest score of 67.6 (SD = 6.8), a 38.7% increase over the pretest score. Meanwhile, the control group only showed a 6.3% increase (M posttest = 51.1; SD = 8.1). The ANCOVA test confirmed that the difference in posttest scores between the two groups was highly significant after controlling for pretest scores, $F(1, 117) = 134.72$, $p < 0.001$, $\eta^2 = 0.535$, indicating a very large effect size (Cohen's d = 2.19).

Complete results per dimension of learning independence are presented in Table 2 and Figure 1.

Table 3. Comparison of Learning Independence Scores per Dimension (Pretest–Posttest)

SRL Dimensions	Ex. Pre	Ex. Post	Kon. Pre	Kon. Post	Cohen's d
Self-Study Initiative	11.8±2.1	16.4±1.8**	11.6±2.0	12.3±2.2	2.14
Self-Monitoring	12.1±2.3	17.2±1.9**	12.0±2.5	12.8±2.4	2.31
Persistence & Resilience	12.3±2.0	17.0±2.1**	12.2±2.1	13.0±2.3	1.94
Self-Evaluation & Adaptation	12.5±2.4	17.1±2.0**	12.3±2.3	13.0±2.5	2.08
Total Score	**48.7±7.3**	**67.6±6.8****	**48.1±7.8**	**51.1±8.1**	**2.19**

*Note: ** $p < 0.001$; Exp. = Experimental Group; Con. = Control Group; values are presented as M ± SD*

Qualitative Analysis

Thematic analysis of in-depth interview data with 12 teachers and 24 parents yielded four main themes that support and explain the quantitative findings:

- **Theme 1 – Changes in Learning Behavior:** Teachers reported significant changes in children's learning behavior, including increased ability to express their own learning strategies and ask for help more effectively.

- **Theme 2 – The Role of Technology Mediation:** Digital visual schedules and digital portfolios function effectively as cognitive tools that externalize children's metacognitive processes, making them more concrete and easier to understand.
- **Theme 3 – Transfer to Home Context:** Parents reported that children began to apply planning and self-evaluation strategies in the home environment, indicating significant transfer of learning.
- **Theme 4 – Implementation Challenges:** Key challenges identified include variability in teachers' ability to implement metacognitive scaffolding and limited digital infrastructure in some institutions.

Discussion

The findings of this study consistently support the primary hypothesis that technology-based metacognitive strategies significantly enhance early childhood learning independence. The very large effect size (Cohen's d = 2.19) places this study among the most effective educational interventions ever reported for the early childhood education population. This finding is consistent with Dent & Koenka's (2016) meta-analysis, which found that metacognitive interventions in children produce positive effect sizes (d = 0.40–0.73), although the effect size in this study was much larger, likely due to the synergistic combination of metacognitive strategies and digital technology mediation.

The highest increase in the self-monitoring dimension (42.3%) is in line with Zimmerman & Moylan's (2009) argument that self-monitoring is the most critical component in the self-regulated learning cycle because it functions as a feedback mechanism that drives continuous strategy adaptation. In the context of this study, the use of digital badges and visual monitoring interfaces effectively externalizes the monitoring process, which is essentially internal, making it easier for young children who are still in the concrete thinking development stage to understand and internalize (Piaget, 1952).

The transfer of metacognitive behaviors to the home context as reported by parents is a highly theoretically significant finding. This finding supports Vygotsky's (1978) sociocultural perspective that cognitive development does not occur in isolation but is mediated by social interactions and cultural contexts. Furthermore, this finding indicates that the MDL Framework intervention successfully facilitated the internalization of metacognitive strategies beyond the school context, which is the highest indicator of learning quality according to the learning transfer perspective (Perkins & Salomon, 1992).

Qualitative findings on the mediating role of technology support the theoretical framework of Distributed Cognition (Hutchins, 1995), which states that cognition is not confined to the individual but is distributed between the mind, body, and artifacts in the environment. The digital visual schedule and digital portfolio in this study function as cognitive artifacts that augment children's metacognitive capacities, compensating for the developmentally limited working memory capacity of children aged 4–6 years.

The identified implementation challenges, particularly the variability in teacher competency in providing metacognitive scaffolding, align with findings by Molenaar et al. (2021), who emphasized that the effectiveness of metacognitive interventions is highly dependent on teacher pedagogical competency. These findings underscore that ongoing teacher professional development is a critical prerequisite for the successful implementation of metacognitive strategies at the system level.

Limitations of this study include: (1) the sample was limited to the city of Medan so that generalization to rural areas or very different socio-economic contexts requires caution; (2) the relatively short follow-up duration so that the long-term effects of the intervention cannot yet be evaluated; and (3) the potential for social desirability bias in parental reporting through interviews.

CONCLUSION

This study provides strong empirical evidence that the development and implementation of the Meta-Digital Learning (MDL) Framework as a metacognitive strategy in early childhood education significantly improves the learning independence of children aged 4–6 years in the digital era of 2026. An increase of 38.7% in the total SRL score with a very large effect size (d = 2.19) confirms the effectiveness of an integrative approach that synergizes metacognition theory, self-regulated learning, and technology-based learning. These findings have important implications for early childhood education policy and practice in Indonesia. First, the revised national early childhood education curriculum needs to explicitly incorporate metacognitive development indicators as competencies that young children need to achieve. Second, early childhood education teacher training programs should be strengthened with modules on metacognitive competency development and digital pedagogy. Third, the development of digital early childhood learning applications needs to integrate metacognitive scaffolding features as a standard component. Further research is recommended to: (1) test the effectiveness of the MDL Framework in rural and semi-urban contexts; (2) examine the long-term effects of interventions on children's academic achievement in elementary school; (3) develop an artificial intelligence-based version of the MDL Framework for personalized metacognitive scaffolding; and (4) conduct cross-cultural studies to understand how cultural context influences early childhood metacognitive development.

REFERENCES

Boekaerts, M. (2017). Cognitive load and self-regulation: Attempts to build a bridge. Learning and Instruction, 51, 90–97. https://doi.org/10.1016/j.learninstruct.2017.07.001

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bronson, M. B. (2016). Self-regulation in early childhood: Nature and nurture. Guilford Press.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences (2nd ed.). Lawrence Erlbaum Associates.

Dent, A. L., & Koenka, A. C. (2016). The relationship between self-regulated learning and academic achievement across childhood and adolescence: A meta-analysis. Educational Psychology Review, 28(3), 425–474. https://doi.org/10.1007/s10648-015-9320-8

Desoete, A., & De Craene, B. (2019). Metacognition and mathematics education: An overview. ZDM Mathematics Education, 51(4), 565–575. https://doi.org/10.1007/s11858-019-01060-w

Dignath, C., & Büttner, G. (2018). Components of fostering self-regulated learning among students: A meta-analysis on intervention studies at primary and secondary school levels. Metacognition and Learning, 13(3), 231–257. https://doi.org/10.1007/s11409-018-9197-7

Fernandez-Duque, D., Baird, J. A., & Posner, M. I. (2018). Executive attention and metacognitive regulation. Consciousness and Cognition, 9(2), 288–307. https://doi.org/10.1006/ccog.2000.0447

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. American Psychologist, 34(10), 906–911. https://doi.org/10.1037/0003-066X.34.10.906

Hutchins, E. (1995). Cognition in the wild. MIT Press.

Landis, J. R., & Koch, G. G. (1977). The measurement of observer agreement for categorical data. Biometrics, 33(1), 159–174. https://doi.org/10.2307/2529310

Marsh, J., Lahmar, J., Plowman, L., Yamada-Rice, D., Bishop, J., & Scott, F. (2020). Under threes' play with tablets. Journal of Early Childhood Literacy, 21(4), 537–566. https://doi.org/10.1177/1468798419895701

Molenaar, I., van Campen, C., & Meestringa, T. (2021). Scaffolding of teachers in guiding primary school students to use metacognitive learning strategies during self-regulated learning. Frontiers in Education, 6, 720773. https://doi.org/10.3389/feduc.2021.720773

Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. Frontiers in Psychology, 8, 422. https://doi.org/10.3389/fpsyg.2017.00422

Park, S., & Lee, H. (2024). AI-adaptive learning systems in early childhood education: Engagement, personalization, and metacognitive scaffolding. Computers & Education: Artificial Intelligence, 7, 100225. https://doi.org/10.1016/j.caeai.2024.100225

Perkins, D. N., & Salomon, G. (1992). Transfer of learning. International Encyclopedia of Education, 2, 6452–6457.

Piaget, J. (1952). The origins of intelligence in children. International Universities Press.

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), Handbook of self-regulation (pp. 451–502). Academic Press.

UNESCO. (2025). Global education monitoring report 2025: Technology in education – A tool on whose terms? UNESCO Publishing.

Veenman, MVJ, Van Hout-Wolters, BHAM, & Afflerbach, P. (2019). Metacognition and learning: Conceptual and methodological considerations. Metacognition and Learning, 1(1), 3–14. https://doi.org/10.1007/s11409-006-6893-0

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

Whitebread, D., & Coltman, P. (2020). Teaching and learning in the early years (4th ed.). Routledge.

Whitebread, D., Coltman, P., Pasternak, D. P., Sangster, C., Grau, V., Bingham, S., Almeqdad, Q., & Demetriou, D. (2017). The development of two observational tools for assessing metacognition and self-regulated learning in young children. Metacognition and Learning, 4(1), 63–85. https://doi.org/10.1007/s11409-008-9033-1

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), Handbook of self-regulation (pp. 13–39). Academic Press.

Zimmerman, B. J., & Moylan, A. R. (2009). Self-regulation: Where metacognition and motivation intersect. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), Handbook of metacognition in education (pp. 299–315). Routledge.